Cape Fear River Booming Strategies

Site Specific Protection Plans

The North Carolina coast, the Cape Fear and New Brunswick Rivers, and their associated natural resources form an ecosystem that is both unique and fragile. The traffic routes used by barges and tankers to transport petroleum products into and out of the Wilmington area makes the entire shoreline vulnerable in the event of a petroleum spill. Located along this shoreline are a number of invaluable economic and natural resources such as wetlands, and concentrations of finfish and wildlife which require protection from catastrophic or chronic petroleum spills associated with petroleum product shipments.

Pre-spill planning is the most effective means to minimize the adverse impacts of a petroleum spill on these critical and vulnerable areas. This planning effort requires the following elements:

- Identification of environmental and economic areas that would be adversely affected by a petroleum spill.
- Preparation of protection plans for those areas where protection is considered feasible.

Sites were selected on the basis of ecological importance as identified in the Area Contingency Plan (ACP), sensitivity to petroleum and feasibility of protection. Emphasis was placed on protecting areas that contain the environmental and economic resources such as wetlands, tidal creeks and rivers, beaches and intertidal flats. Many of these areas can only be protected by deflection type booming operations and many are accessible only by water.

Format and Definition of Terms

Each site report contains a variety of sections and subsections, which are always presented in the same order. This allows rapid scanning of the text to locate the desired information. The format for the site report is outlined below, together with a brief discussion of the categories and any related terms.

Geographic Identification

SITE NAME(S)	Common name for the site.
LOCATION:	Site location, direction and distance from the terminal.
WATERBODY:	The main waterbody connected to the site.
PRIORITY:	The terms low, medium and high are used to describe the priority of a site for protection from a petroleum spill based upon site characteristics; however, the actual order of protection will depend upon a number of unpredictable factors such as weather conditions, water levels and currents.

Site Characteristics

Shoreline/Habitat to be Protected

The type of shoreline and/or critical habitat located at the site.

Endangered Species

A listing of the endangered species that may be found at or near the site.

Bird Concentrations

The North Carolina Atlantic Coast provides pathways for a wide variety of migratory waterfowl. Significant concentrations of waterfowl, shorebirds and marsh birds inhabit the area year round; concentrations of these birds near the site of a major petroleum spill may require bird salvage and cleaning operations.

Access Routes

This section identifies the primary route used to enter the site. Secondary access may be identified if an alternate access is available.

Land Use

This section contains a brief description of basic land use patterns near the site.

Protection Plan

This section identifies the basic resources, equipment and techniques to be used in the protection of the site. The detailed protection requirements must be determined by the Unified Command considering the conditions at the time of the incident.

Predicted Oil Behavior

Identifies the typical behavior of oil with the shoreline types found at the site.

Response Considerations

Identifies the most common cleanup procedures used for the shoreline types found at the site.

Containment and Cleanup

Many techniques and equipment are available to petroleum spill response personnel. The effectiveness of the different types of equipment depends primarily on the conditions at the time and place of the spill. Briefly discussed below are a few of the more common techniques used in petroleum spill protection and cleanup practices.

Location, Containment and Recovery

LOCATION

Spills of Group V oils that sink or become neutrally buoyant are likely to be difficult to locate and assess. The options for locating sunken oil include aerial observations in clear water, diver transects, underwater video, and sonar equipment. All remote observations have to be verified with diver surveys. Diving conditions can be very difficult because the divers are likely to become heavily contaminated from the oil in the water column and re-suspended from the bottom. There are no proven techniques for location of the oil that is neutrally buoyant and suspended in the water column.

CONTAINMENT – CONVENTIONAL SPILLS

One of the first activities undertaken when a petroleum spill occurs is to confine the petroleum to as small an area as possible and to prevent its spread into vulnerable areas. Since many spills occur during poor weather conditions, containment is frequently difficult and sometimes impossible.

The first type of equipment normally used is a containment boom. Heavy-duty, floating boom that extends up to 3 feet down into the water can be effective in containing product in protected waters as long as wave heights are not greater than 3 to 4 feet. Even under these conditions, there can still be a considerable loss of petroleum as a result of entrainment (product forced under the boom) or overwash. Lighter-duty booms are commonly used in calmer sea conditions and in shallow areas near shore. This type of boom is generally 18 inches in depth and

can be used to surround the spill for skimming, to block an entrance channel (if currents are not too swift), or to deflect the petroleum to a less sensitive shoreline access point for land based pickup. Special training is necessary to deploy all types of boom effectively.

CONTAINMENT – GROUP V OILS

Historically, sunken oil was not actually contained but instead tended to accumulate in natural collection areas. Any oil that was mobilized by currents was not contained. Although bottom booms have been proposed, it is not likely that they will be effective in any kind of bottom currents, or even properly deployed on the bottom in an effective location. Realistically, the only likely containment of sinking oil will occur naturally as the oil accumulates in low areas on the bottom at the spill site.

Containment of oil that is suspended or mixed into the water column is feasible only where the currents are very weak. Options include silt curtains or fine-mesh nets coupled with a surface boom to contain the floating or re-floating fraction of the oil. The use of the curtain booms is successful in areas of extremely low currents.

RECOVERY –Conventional Spills

Depending on the circumstances, the cleanup of contained petroleum can be accomplished using a skimmer vessel, absorbents and manual labor. A variety of sophisticated equipment is now available which can be used to skim the surface of oiled water. Among the options available to cleanup personnel are devices which vacuum the petroleum off the water's surface, such as floating suction heads and floating weirs which require the use of skimmer pumps, and rotating drum and belt skimmers which adsorb the petroleum. All are designed to deposit the petroleum in a containment vessel such as a sump, tank, a barge or an onshore vacuum truck for later disposal at a disposal site. Skimmers work most effectively on thick, heavy, petroleum slicks, and the sooner they can be used after a spill occurs, the better. Rough seas limit their efficiency and some cannot be used in shallow water. Since skimmers that use pumps take up large amounts of water, separating the petroleum from the resulting emulsion is a problem. In general, if skimmers can be brought onto a petroleum spill scene rapidly, and if weather and tidal

current conditions permit, they are effective in recovering petroleum.

Sorbents are materials designed to float on the water and absorb spilled product. Petroleum product adheres to the outside of the absorbent particle or is taken into the material by capillary action. The primary use of absorbents is for small or medium-sized spills and for final cleanup of petroleum films after mechanical skimming operations. They are also used for mop-up of soiled shorelines and where the use of skimming equipment is difficult.

Sorbent materials should meet four basic criteria:

1. They should be easy to handle.

2. They should be nontoxic and non-persistent in the environment.

3. They should be easily recovered.

4. They should be easily disposed.

RECOVERY – Group V Spills

Recovery of sunken oil has proven to be very difficult and expensive. Options include:

1. Manual removal by divers.

2. Removal by diver-directed pump and vacuum systems

3. Dredging

4. Use of robotic pumping systems

Manual removal involves the collection of the oil by divers into bags or containers. The advantages of manual removal are:

The volume of material removed is the lowest of all options. Little additional water or sediment would be removed, therefore, there will be no need to treat oily water or dispose of large amounts of oiled sediment.

Divers will be able to pick up relatively small pieces, which may be widely scattered over large areas.

The recovered oil can be placed directly into suitable containers for disposal. There would be less need for intermediate storage or transfers.

The biggest disadvantage of manual removal is the slow rate of recovery. The potential for the oil to spread to other areas may force a more rapid recovery strategy.

Removal by pump and vacuum systems has historically been the most successful removal strategy for sunken oil. Such systems can include vacuum trucks, units mounted on barges, and submersible pumps. They often are diver-directed and the suction head modified so that the diver manually opens and closes the valve. The oil must be liquid to be pumped. Because large volumes of oily water are generated, there must be facilities for oil/water separation and discharge of the separated water. Separation can be very problematic for some Group V oils, especially when they are heavier than water and only part of the oil tends to re-float.

Dredging is the fastest method for removing sunken oil from the bottom, but will generate very large volumes of oily water and sediment that must then be handled, treated, and disposed of. Pumping rates of 1,000 gallons-per-minute are typical of small dredges. Even under careful control, dredges often remove the top 1.5 feet of material, removing and contaminating a large amount of clean sediment. Logistics and costs are reduced if the material can be handled on land, compared to using barges or temporary storage and separation. Time can be of concern because oil that is still fluid could be re-mobilized by storm waves, increased river flow following heavy rains, or ship traffic.

Recovery of oil that is suspended in the water column poses the most difficult challenge. Fishnets have not been very successful for recovery of firm tarballs; they are likely to be even less effective with liquid oil droplets. The net mesh size would have to be matched to the droplet size. Heavy accumulations would clog the nets, resulting in breakage or failure.

Temporary Filling of Channels

In many places along the shore, it may be possible to protect fragile areas by temporarily filling in the entrance channels to embayments, coves or tidal marshes. This option, in particular, requires that the UNIFIED COMMAND exercise sound judgment based on the conditions at the time. For example, if a spill occurs outside a cove during an ebbing tide, there is little, if any, potential for petroleum to enter the channel until the tide turns. By then, the petroleum may have moved on to some other area or may have been contained. Under these circumstances, it may be reasonable to avoid the filling operation. However, in many situations it may be necessary to fill in a channel with sand or some other unconsolidated material using equipment such as a bulldozer or backhoe to prevent the infiltration of petroleum into an area. The use of heavy equipment on riverbanks and salt marshes should be carefully controlled to minimize damage to the resource.

The action of filling tidal or inland waters is a regulated activity. For coastal areas, time permitting, the OSC should coordinate this activity with the appropriate regulatory units, especially the U.S. Army Corps of Engineers and the North Carolina Department of Environment and Natural Resources.

Regardless of the type and severity of a spill, a considerable amount of physical labor is involved in cleanup operations. Boom deployment, the application of absorbents, and the use of skimming equipment all require trained personnel. If product comes ashore, the manpower requirements rise dramatically. In some cases heavy equipment will be needed to remove contaminated soils on shore. In other instances, effective cleanup can be accomplished by the use of rakes and shovels. In all instances, the most efficient cleanup efforts are those involving trained personnel.

The Petroleum Spill Threat

The OSC, response personnel and the equipment they use must be capable of handling a wide range of petroleum spill emergencies. Factors such as the type and amount of product spilled, weather conditions and location, all contribute to the uncertainty that faces response personnel when they handle a spill emergency.

Types of Petroleum Products

All petroleum products can damage vulnerable coastal features, however, some are longer lasting and have a more severe impact. The lighter weight products include naphtha, gasoline, diesel fuel, kerosene and No. 2 heating oil. Many of these fuels will evaporate when exposed to air, but even small amounts of these lightweight, toxic products can have a lasting effect on wetlands or other fragile environments.

Nature of the Spill

The amount of product spilled and the speed with which it is introduced into the marine environment also influences the decisions of the Unified Command. A large amount (several thousand gallons) of product normally presents a more difficult challenge than a small spill. Similarly, the sudden release of product from a collision generally causes more problems for response personnel than the slow leakage of product from a crack in the hull of an oil tanker.

Once the product enters the water, weather and tidal conditions begin to play a large role in the direction and speed of product movement. In general, the wind controls the spill's movement except where fast currents, such as those found in rivers, are a major influence. Not only does the wind control the movement of product, but also the stronger it blows the larger the waves and the more difficult it becomes to use cleanup equipment.

The time delay between the occurrence of a petroleum spill and the beginning of containment activities can be a major factor in determining the amount of damage done by a spill. The sooner the alarm is sounded the better the chances are that the response team can control the spill and minimize damage.

Resource Types and Protection Priority

The primary concern in the event of a petroleum spill in the Cape Fear River area is the protection and cleanup of the shoreline and sensitive areas. There will be emergencies where the personnel and equipment are not available to protect everything, and decisions will have to be made concerning what to protect first, and what areas will have to be assigned a lower priority. This guide identifies those areas which could be significantly damaged by spilled petroleum, which are the most fragile of the shoreline environments and which should be considered as priority candidates for protection.

The public agencies involved in petroleum spill cleanups recognize that they have a responsibility to protect as much of the shoreline as they can.

The following provides a brief overview of the basic coastal resources and their vulnerability to spilled Group V petroleum products. During a lighter than water petroleum spill, responders typically have to deal with recovery of floating oil slicks and shoreline cleanup. The focus is on the water surface and shoreline and benthic resources are usually considered to be at lesser risk of exposure and injury. Group V petroleum spills may significantly change these risks.

Tidal Wetlands

Shoreline Habitats

Salt marshes are highly susceptible to oiling impacts from traditional oil spills. Floating oil slicks readily adhere to the vegetation, whereas oil stranded on the substrate tends to be lifted off the water-saturated sediments by rising tides. Floating and neutrally buoyant Group V fuel oils could pick up enough sediment in the marshes to accumulate on the sediment surface and not re-float during high tide. Efforts to remove oil

stranded on soft, muddy, vegetated sediments would likely cause extensive additional disruption of roots, mix oil deeper into the sediments, and prolong recovery.

Marshes are often associated with tidal flats both exposed and sheltered. Many species of larval fish, shellfish, bivalves, gastropods, and other invertebrates are obligate inhabitants of tidal flats. Floating oil slicks are usually lifted off the tidal flats with the rising tide. Group V fuel oil could strand on the flats during low water and pick up enough sediment to prevent re-floating. Weathered oil is also likely to be very viscous and strand in thicker deposits or globules; these larger oil deposits would be more resistant to natural removal. As a result, stranded Group V fuel oil on tidal flats may be more persistent and result in higher impacts to tidal flats and the animals associated with them. Stranded oil could be removed from sandy tidal flats, although there is a high likelihood that some oil would be mixed deeper into the sediment by foot traffic. Removal of heavy, viscous oil from soft, muddy flats would be extremely difficult, and natural removal rates would be very slow. Subsequently, impacts to animals and plants using these habitats could be more likely.

Gravel beaches and riprap structures have been shown to accumulate oil, often to depths exceeding one meter (Hayes et al. 1990). Fresh oil often penetrates the large interstitial spaces and fills the voids, thus providing a source of long-term contamination to intertidal and near-shore subtidal biota. With Group V oils, thick coating of the individual clasts is expected. It is predicted that there will be less penetration of Group V oils into the sediments because of its increased viscosity. In these habitats, Group V oil is not expected to behave much differently than a typical #6 fuel oil. However; gravel beaches and riprap structures are extremely difficult to clean. Surface cleanup can be accomplished through various methods, but the only effective way to treat persistent subsurface oiling is through sediment reworking, or removal and replacement. This is a very costly procedure in terms of both dollars and impact to the habitat and species that use it.

On sand beaches and mixed sand and gravel beaches, oil will accumulate along the high tide swash line, and under heavy oiling conditions, the entire beach face can be covered. There is however, little oil penetration into the sediments, usually to depths less than 25

cm. In areas undergoing beach accretion, clean layers of sand can rapidly bury stranded oil. A Group V oil spill is unlikely to significantly alter the oiling of these habitats, although the depth of penetration of more viscous oils into the sediments is likely to be reduced. As a result, cleanup can be relatively easy – mechanical and manual cleaning of these beaches is often logistically feasible. Oil that has sunk offshore could provide a source of long-term re-oiling of cleaned beaches.

Coastal structures include exposed and sheltered man-made structures like seawalls, bulkheads, and piers. Oiling of these structures usually takes the form of a continuous band of oil along the high-tide line. Oiling effects from Group V oils are unlikely to differ significantly from spills of other oils; coating of these coastal structures may be thicker and may occur throughout the intertidal and subtidal zone, but response operations are unlikely to be significantly altered. In exposed settings, cleanup is not necessary except in areas where it is required for aesthetic reasons. For these areas, high-pressure, hot-water washing is often used.

Many of the riverine environments have extensive marshes and swamps associated with them. For spills in the riverine environment heavy contamination typically occurs along the wetland fringe, in side channels with significant flow, and in river bends (point bars) where the oil may accumulate. Spills of Group V oils are more likely to sink in fresh water. In areas of low flow and natural collection sites, non-floating Group V oil would tend to accumulate. Tracking sunken oil in riverine environments will be difficult because of poor water visibility. Under weak currents, the oil would be less likely to spread, so the effects would be very localized.

The forests that border the river are considered least at risk from exposure to Group V oil spills. For the most part, the plants associated with this habitat have deep root systems. Any coating of the exposed portion of these plants is unlikely to result in injury other than stress. If the leaf matter is coated, the plant's photosynthetic abilities could be impaired, resulting in defoliation of the affected areas on the plants.

Benthic Habitats

Submerged aquatic vegetation beds are important primary producers and nursery habitats. Wigeon grass, eelgrass, and turtle grass are several of the more common species in habitats in the nearshore environment. During most oil spills, seagrass habitats are not generally considered to be at great risk, unless the beds are intertidal. Group V oil spills are likely to: readily adhere to the seagrass blades; affect the animals and plants that are associated with the vegetation; become buried in areas exposed to some currents and mobile, sandy substrates; and be a long term source of shoreline contamination as the submerged oil is re-floated when disturbed or warmed.

Biological Resources at Risk

Many of the resources considered at risk from exposure to Group V oils are the animals themselves. Many species utilize multiple habitats, and therefore can be associated with particular habitats during different life stages. The various factors that are important to each species are discussed in terms of preferred habitat and life-stage data. The general species categories considered at risk include birds, fish, shellfish, reptiles and marine mammals.

Birds

U.S. waters and waterways are host to numerous bird species, including the general categories of seabirds, shorebirds, wading birds, waterfowl, gulls and terns, raptors, and songbirds. In general, the degree and extent of injury from exposure to Group V oil is dependent on species' feeding and nesting behavior.

Shorebirds (e.g., oyster-catchers, plovers) and wading birds (e.g., herons, egrets, wood storks) forage at the water's edge and in wetlands. Historically, these birds have been only moderately affected during oil spills because they do not tend to immerse their bodies in water. Oil can cause loss of their preferred prey items, and external coating of legs, feet, and bills during foraging efforts. Effects on these birds from Group V oil spills are likely to be similar to a #6 oil spill, or even lower if most of the oil sinks. The only increase in impact may be where a Group V oil spill contaminates the sediments on tidal flats where the birds rest or forage.

Waterfowl, gulls and terns, and seabirds, by their very nature, are likely to be affected by floating Group V oil in ways expected during usual oil spills. These birds are closely associated with the water surface in feeding and resting activities and, as such, there is the potential for these birds to become oiled and die from hypothermia or loss of buoyancy. It is not known whether these birds experience additional oil exposure when diving for prey if the oil is mostly mixed into the water column and not floating on the water's surface. Suspended oil is not expected to be sticky but some birds spend so much time underwater searching for food that they may have some risk of exposure. In general, oil related impacts to water birds are likely to somewhat

reduced for non-floating oils.

The bald eagle, osprey, and peregrine falcon are common raptors found nesting and foraging throughout the coastal zone. Osprey are at risk of being directly oiled because they feed on live fish; eagles and falcons are subject to secondary contamination through the consumption of oiled food, such as dead, oiled seabirds or rodents. Group V oil spills are thought to pose no additional risks to raptors; rather, they are likely to be reduced because of the fewer number of birds in the impact zone.

Fish

Floating oil spills usually have limited impacts on adult and juvenile fish, as most oils have very low water-soluble fractions, and the mobile fish are able to avoid petroleum products. Larval stages that float at or close to the water surface are at greatest risk. Non-floating oil spills are likely to have significantly different impacts to fish. Sinking oil can smother and kill bottom feeders and their food, though impacts are likely to be localized. In addition, oils that quickly sink or suspend in the water column could have greater impacts to water-column organisms because more of the water-soluble fraction of the oil could actually dissolve rather than be lost by evaporation.

Group V oil is often high in aromatics, which are the primary source of both acute and chronic toxicity to aquatic organisms. The naphthalene compounds, which are two-ringed aromatics, have been shown to be more toxic than the lightweight aromatics such as benzene and toluene. If only the water-soluble fraction is considered, bunker C is rated as toxic as diesel. Thus, even though heavy residual oils are not usually considered acutely toxic to fish, spills that mix into the water column without first weathering (by evaporation) on the water surface may increase the amount of oil that dissolves and the acute toxicity to fish.

Shellfish

Various species of shrimp, crab, clams, oysters, scallops and other important gastropods and cephalopod mollusks are found in coastal waters. Most adult and juvenile shellfish are primarily bottom dwellers that scavenge the substrate or filter the overlying waters for food. Floating oil spills usually have limited impacts to these organisms. In contrast, sinking and neutrally buoyant Group V oil spills are expected to

have direct impacts to crabs and shrimp, as well as clams, oysters and other mollusks due to both acute toxicity and tainting of the flesh. The aquatic toxicity of oil to shrimp is closely related to the naphthalene content, so any process that tends to increase the amounts of these compounds in the water would also increase the impacts to shrimp.

There have been multiple spills of heavy oil that have sunk where oiled crabs were found in crab pots many miles downstream of the spill. Crabs and shrimp are opportunistic omnivores, which means that they will eat almost anything they can catch, and they will attempt to feed on oil, oiled prey, and oiled sediments. Thus, even though heavy oils are not normally considered to be biologically available to most marine organisms, crab and shrimp may be more susceptible than other organisms because of their benthic scavenging habits.

Reptiles

Within coastal waters, sea turtles, alligators, and terrestrial turtles have the potential to be affected by Group V oil spills in their preferred habitats. Many exposed beaches are nesting beaches for loggerhead turtles in the spring and summer. Other turtle species, which may be encountered less frequently, include green turtles, hawksbill turtles, Atlantic Ridley's turtles and leatherback turtles. It is assumed that offshore Group V oil spills are likely to be difficult to recover and thus generate persistent tarballs that could eventually concentrate in convergence zones where turtles are concentrated to feed. Therefore, adult and juvenile turtles are more likely to be affected by floating Group V oil spills through ingestion of tarballs, having tarballs stuck in their mouths, and/or having tarballs adhering to their flippers and shells.

Group V oil stranded on sand beaches is less likely to penetrate the sand than more fluid oil because of its viscosity. However, oil that sank offshore could provide a source of episodic oiling during the nesting season as the submerged oil is re-mobilized during storms, weeks or months after the cleanup of the stranded oil has been completed.

Juvenile sea turtles are known to feed on crabs and other benthic inhabitants of the nearshore zone, making them susceptible to bottom oil in the form of tarballs, rollers and submerged mats.

Although American alligators, and endangered terrestrial turtles use both the water surface and the water column, impacts from a Group V oil spill are not likely to be much different than usual oil spills.

Marine and Terrestrial Mammals

There are numerous species of marine mammals that may be affected by an oil spill including whales, dolphins, porpoise, seals, and otters. In the terrestrial environment, large rodents, river otter and other small mammals could also be affected by a spill of petroleum products in inland waterways. The effect of spill oil depends largely on the individual species thermoregulatory process, the amount of time the animals are associated with the water surface, and their dietary requirements. Marine and terrestrial mammals are likely to be impacted by spilled oil in four ways: direct surface fouling; inhalation; ingestion; and the direct disturbance to the animals due to the presence of cleanup equipment and personnel.

In general dolphins and porpoises are largely unaffected by spilled petroleum products. These mammals have thick blubber layers for insulative purposes – a surface coating of oil would be more of an irritant than life threatening. Heavy oils have little volatile fractions so the risk of exposure via inhalation would be reduced. Suspended oil is not likely to adhere to the surface of these animals, so the only route of concern would be through ingestion of oil in their food. It is unlikely that the concentrations of fish or plankton in an area affected by suspended oil would be high enough to induce feeding by marine mammals.

The furred animals such as seals and terrestrial mammals are more at risk to oil impacts because their fur coat is the basis for their thermoregulatory systems. Oiling of their coats results in increased metabolism as their bodies try to counteract the reduction in their thermoregulatory system effectiveness. If oiled, furred animals can ingest oil while trying to clean their coat and burn up their energy reserves in order to regulate their body temperatures. In most cases, impacts to these animals would be reduced for non-floating oil spills, when less oil is on the water surface or likely to strand on haul outs (waterway entry and exit points used by the mammals) and pupping sites. Sunken oil would be less weathered, persistent, and more likely to come in contact with animals when they are resting and feeding on

the bottom. During foraging efforts, the eyes, nose, mouths, and paws or flippers of these mammals could become coated in ways typically not incurred from spills of floating oils, primarily if tar mats were to accumulate in their preferred feeding areas. Over time, the mats do weather and the oil can become sticky.

Summary

Because Group V oils can float, sink, become neutrally buoyant, or separate and possess all three characteristics, it poses significantly greater risks to natural resources, compared to floating oil spills, for the following reasons:

Neutrally buoyant or sinking Group V oil weathers very slowly by evaporation, a process which tends to remove the more toxic fractions from floating oil slicks and greatly reduces the acute toxicity of the spilled oil. As a result, the toxic components of a Group V oil spill can be introduced directly into the water column at concentrations greater than traditional spills. Animals in the water column, such as fish, shellfish and marine mammals, can be exposed to these higher concentrations.

Group V oil that is denser than the receiving waters is not expected to sink immediately to the bottom and remain there. More likely, it will be suspended in the water column by tidal or riverine currents. Accumulations of oil on the bottom is expected only in depressions or zones of low flow, such as dredged channels, dead-end waterways, abandoned channels, or protected bays and lagoons.

Benthic organisms are seldom at risk from traditional oil spills. However, with heavier-than-water spills, additional impacts to benthic resources are likely to occur from smothering as well as increased exposure to residual oil that was not recovered. As a corollary, impacts to shoreline habitats and animals that use both the shoreline and water surface would be less from sinking oils.

Containment and removal efforts for sinking oil will have low effectiveness. Removing submerged oil is very slow and usually generates large volumes of contaminated water and sediment.

Containment and removal efforts for neutrally buoyant oil will likely be ineffective. There are no proven techniques for containing oil in the water column, or for removing oil from large volumes of water.

Standard techniques for location, containment, and recovery will fail unless personnel experienced in the proper deployment and maintenance of the equipment and special requirements of oil-spill response conduct them.

A spill of Group V oil is not likely to affect any one resource of special importance. The potential for a widespread presence of spilled Group V oil on the water surface, in the water column, and on the bottom will tend to affect the entire range of resources (e.g., fish, shellfish, marine mammals, birds, etc.). Additional injuries to fishery and shellfish resources are more likely to occur. Present response technology is ill equipped to deal with the potential water-column and benthic habitat impacts from a Group V oil spill.

Site 1 - Ness Creek

Identification

Site Name:	Ness Creek
Location:	North approximately 7.9 miles
Waterbody:	Cape Fear River
Priority:	Low

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Rare & Endangered Species

- Shortnose Sturgeon
- American Alligator

Bird Concentrations

- High: Wood Duck, King Rail
- Low: Green Winged Teal

Land Use

- Undeveloped

Seasonal Considerations

- Alewife spawning March through May.
- American Alligator nesting June through July with hatchlings August through September.
- Brackishwater Clam spawning and larvae March through May and August through September

SPILL RESPONSE

Predicted Oil Behavior

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Protection Plan

Approximately 500 feet of boom should be deployed across the creek channel at this location. This will prevent petroleum from contaminating in inland reaches of the creek and the associated shorelines. This site should be considered on an incoming tide only. A minimum of six (6) anchor sets will be required to properly secure the boom. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Site 2 - Smith Creek

Identification

Site Name:	Smith Creek
Location:	North approximately 7.35 miles
Waterbody:	Cape Fear River
Priority:	Low

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Rare & Endangered Species

- Shortnose Sturgeon
- American Alligator

Bird Concentrations

- High: Wood Duck, King Rail
- Low: Green Winged Teal

Land Use

- Undeveloped

Seasonal Considerations

- Alewife spawning March through May.
- American Alligator nesting June through July with hatchlings August through September.
- Brackishwater Clam spawning and larvae March through May and August through September.
- Grass shrimp spawning September through October.

SPILL RESPONSE

Predicted Oil Behavior

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Protection Plan

Approximately 600 feet of boom should be deployed across the creek channel at this location. This will prevent petroleum from contaminating in inland reaches of the creek and the associated shorelines. This site should be considered on an incoming tide only. A minimum of seven (7) anchor sets will be required to properly secure the boom. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Site 3 - Cape Fear River

Identification

Site Name:	Cape Fear River
Location:	North approximately 4.9 miles
Waterbody:	Cape Fear River
Priority:	Medium

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Vegetated Riverine Banks

- Either low banks with grasses or low eroding banks with trees and tree roots exposed to the water.
- The banks are flooded occasionally by high water.
- These shorelines are generally found in fresh or brackish water localities.

Rare & Endangered Species

- Shortnose Sturgeon
- American Alligator

Bird Concentrations

- High - King Rail, Wood Duck
- Low - Green-Winged Teal

Land Use

- Undeveloped to the west and the City of Wilmington to the east.

Seasonal Considerations

- Alewife spawning March through May.
- Mummichog spawning April through September.
- Sheephead minnow spawning April through October.
- Striped Bass spawning March through May.
- American Alligator nesting June through July with hatchlings August through September.

- Brackishwater Clam spawning and larvae March through May and August through September.
- Grass shrimp spawning September through October.

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Vegetated Riverine Banks

- During low water stages there could be little impact, with the oil coating a narrow band of sediment at the water level.
- During high water, the oil will cover and coat the grasses and base of the trees.
- May cause loss of the grasses, but the trees should survive unless oil penetrates and persists in the substrates.

Protection Plan

Approximately 3,000 feet of boom should be deployed in three to four configurations in varying lengths in an effort to direct the oil towards the shoreline. This will prevent petroleum from contaminating the upstream reaches of the river. This site should be considered on an incoming tide only. The site is rather large and boom deployment across the entire river would not result in protection at this site. The deflection of oil to collection areas would move the oil into the slower current areas of the river and help during tidal changes. A minimum of thirty-six (36) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent boom tending. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Vegetated Riverine Banks

- Low-pressure flushing of oiled areas is effective in removing moderate to heavy accumulations of oil from along the banks.
- Sorbent and containment boom should be placed on the waterside of cleanup operations to contain and collect oil outflow.
- Low-to-high-pressure flushing can be used to remove oil from the tree roots and trunks, if deemed necessary in high-use areas.

Site 4 - Battleship North Carolina

Identification

Site Name:	Battleship North Carolina
Location:	North approximately 4.7 miles
Waterbody:	Cape Fear River
Priority:	Medium

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Sheltered Manmade Structure

- These structures are solid manmade structures such as seawalls, groins, revetments, piers, and port facilities.
- Most structures are constructed of concrete, wood or metal.
- Often there is no exposed beach at low tide, but multiple habitats can be present.
- Most of the structures are designed to protect a single lot; thus their composition, design and condition are highly variable.
- Attached plant and/or animal life can be moderate to high.

Rare & Endangered Species

None Noted

Bird Concentrations

None Noted

Land Use

- Recreation/Commercial

Seasonal Considerations

None Noted

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Sheltered Manmade Structure

- Oil will adhere readily to the rough surface, particularly along the high-tide line, forming a distinct oil band.
- The lower intertidal zone usually stays wet (particularly if algae covered), preventing oil from adhering to the surface.

Protection Plan

Approximately 500 feet of boom should be deployed across the entrance to the canal in which the ship is permanently moored. This will prevent petroleum from contaminating the inner shorelines, seawalls and the ship itself. This site should be considered on an incoming tide only. A minimum of six (6) anchor sets will be required to properly secure the boom. Anchoring points for the boom ends should be readily available. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Sheltered Manmade Structures

- Cleanup of seawalls is usually conducted for aesthetic reasons or to prevent leaching of oil.
- Low-to-high-pressure spraying at ambient water temperature is most effective when the oil is fresh.

Site 5 - Greenfield Marsh

Identification

Site Name:	Greenfield Marsh
Location:	North approximately 3.0 miles
Waterbody:	Cape Fear River
Priority:	Medium

Site Characteristics

Shoreline Type

Salt and Brackish Marsh

- These marshes contain vegetation, which tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Rare & Endangered Species

- None Noted

Bird Concentrations

- None Noted

Land Use

- Undeveloped

Seasonal Considerations

- None Noted

SPILL RESPONSE

Predicted Oil Behavior

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.

- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Protection Plan

Approximately 1,500 feet of boom should be deployed across the marsh line at this location. This will prevent petroleum from contaminating in inland reaches of the marsh and the associated resources. This site should be considered on an incoming tide only. A minimum of sixteen (16) anchor sets will be required to properly secure the boom. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

Site 6 - Port of Wilmington

Identification

Site Name:	Port of Wilmington
Location:	North approximately 0.6 mile
Waterbody:	Cape Fear River
Priority:	High

Site Characteristics

Shoreline Type

Exposed Manmade Structure

- These structures are solid manmade structures such as seawalls, groins, revetments, piers and port facilities.
- They are constructed of concrete, wood or metal.
- Often there is no exposed substrate at low tide, but multiple habitats may be present.
- They are built to protect the shore from erosion by waves, vessel wakes, and currents, and thus are exposed to rapid natural removal processes.
- Attached animals and plants are sparse to moderate.

Salt and Brackish Marsh

- These marshes contain vegetation, which tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Rare & Endangered Species

- None Noted

Bird Concentrations

- None Noted

Land Use

- Industrial/Commercial Port Facility

Seasonal Considerations

- None Noted

SPILL RESPONSE

Predicted Oil Behavior

Exposed Manmade Structure

- Oil is usually held offshore by waves reflecting off the steep, hard surface in exposed settings.
- Oil readily adheres to the dry, rough surfaces, but it does not adhere to wet substrates.
- The most resistant oil would remain as a patchy band at or above the high-tide line.

Salt and Brackish Marsh

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Protection Plan

Approximately 2,000 feet of boom should be deployed across the shoreline at this location. This will prevent petroleum from contaminating the associated marsh and the economic resources of the port. This site should be considered on an incoming tide only. A minimum of twenty (20) anchor sets will be required to properly secure the boom. Boom tending should be continuous to ensure the security of the protection of the port and should be coordinated with the Port Authority. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Exposed Manmade Structure

- Cleanup is usually not required.
- High-pressure water spraying may be conducted to: remove persistent oil in crevices, improve aesthetics, or prevent the leaching of oil.

Salt and Brackish Marsh

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

Site 7 - Redmond Creek

Identification

Site Name:	Redmond Creek
Location:	North approximately 4.1 miles
Waterbody:	Brunswick River
Priority:	High

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Rare & Endangered Species

- Shortnose Sturgeon
- American Alligator

Bird Concentrations

- High - King Rail, Wood Duck
- Low - Mallard, Green-Winged Teal

Land Use

- Undeveloped

Seasonal Considerations

- Alewife spawning March through May.
- American Alligator nesting June through July with hatchlings August through September. High concentrations of Alligators throughout the area.
- Brackishwater Clam spawning and larvae March through May and August through September.
- Grass shrimp spawning September through October.

SPILL RESPONSE

Predicted Oil Behavior

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Protection Plan

Approximately 800 feet of boom should be deployed across the creek channel at this location. This will prevent petroleum from contaminating in inland reaches of the creek and the associated shorelines. This site should be considered on an incoming tide only. A minimum of nine (9) anchor sets will be required to properly secure the boom. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. This site is located on the Brunswick River

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Site 8 - Brunswick River

Identification

Site Name:	Brunswick River
Location:	West approximately 0.5 miles
Waterbody:	Cape Fear and Brunswick Rivers
Priority:	High

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Vegetated Riverine Banks

- Either low banks with grasses or low eroding banks with trees and tree roots exposed to the water.
- The banks are flooded occasionally by high water.
- These shorelines are generally found in fresh or brackish water localities.

Fine Grained Sand Beaches

- These beaches are generally flat and hard-packed.
- Although these beaches are predominantly fine sand, there is often a small amount of shell or shell hash.
- There can be heavy accumulation of wrack present.
- They are utilized by birds and turtles for nesting and feeding.
- Upper beach fauna includes ghost crabs and amphipods; lower beach fauna can be moderate, but highly variable.

Rare & Endangered Species

- Alewife spawning March through May.
- American Alligator nesting June through July with hatchlings August through September.
- Brackishwater Clam spawning and larvae March through May and August through September.

Bird Concentrations

None Noted

Land Use

Undeveloped

Seasonal Considerations

None Noted

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Vegetated Riverine Banks

- During low water stages there could be little impact, with the oil coating a narrow band of sediment at the water level.
- During high water, the oil will cover and coat the grasses and base of the trees.
- May cause loss of the grasses, but the trees should survive unless oil penetrates and persists in the substrates.

Fine Grained Sand Beach

- Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone.
- Heavy oil accumulations will cover the entire beach surface; oil will be lifted off the lower beach with the rising tide.
- Maximum penetration of oil into fine-grained sand is about 10 cm.
- Burial of oil layers by clean sand within the first week after a spill typically will be less than 30 cm along the upper beach face.
- Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water.
- Biological impacts include temporary declines in fauna, which can affect important shorebird foraging areas.

Protection Plan

Approximately 3,000 feet of boom should be deployed in three to four configurations in varying lengths in an effort to direct the oil towards the shoreline. This will prevent petroleum from contaminating the upstream reaches of the river. The site is rather large and boom deployment across the entire river would not result in protection at this site. The deflection of oil to collection areas would move the oil into the slower current areas of the river and help during tidal changes. A minimum of thirty-six (36) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent

boom tending. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Vegetated Riverine Banks

- Low-pressure flushing of oiled areas is effective in removing moderate to heavy accumulations of oil from along the banks.
- Sorbent and containment boom should be placed on the waterside of cleanup operations to contain and collect oil outflow.
- Low-to-high-pressure flushing can be used to remove oil from the tree roots and trunks, if deemed necessary in high-use areas.

Fine Grained Sand Beach

- These beaches are among the easiest shoreline types to clean.
- Cleanup should concentrate on removing oil and oily debris from the upper swash zone once oil has come ashore.
- Traffic through both oiled and dune areas should be severely limited to prevent contamination of clean areas.
- Activity through both oiled and dune areas should be limited to prevent contamination of clean areas.
- Manual cleanup, rather than road graders and front end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal.
- All efforts should focus on preventing the mixture of oil deeper into the sediments by vehicular and foot traffic.
- Mechanical reworking of lightly oiled sediments from the high tide line to the upper intertidal zone can be effective along outer beaches.

Site 9 - Mallory Creek

Identification

Site Name:	Mallory Creek
Location:	South - downstream approximately 1.2 miles
Waterbody:	Cape Fear River
Priority:	High

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Rare & Endangered Species

- Shortnose Sturgeon
- American Alligator

Bird Concentrations

None Noted

Land Use

Undeveloped

Seasonal Considerations

- Bay Anchovy spawning April through September.
- Mummichog spawning April through September.
- Sheephead minnow spawning April through October.
- Striped bass spawning March through May.
- American oyster spawning May through October.
- American Alligator nesting June through July with hatchlings August through September.
- Brackishwater Clam spawning and larvae March through May and August through September.
- Grass shrimp spawning February through October.

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Protection Plan

Approximately 3,000 feet of boom should be deployed in three to four configurations in varying lengths in an effort to collect the oil and keep it from entering the vast wetland area. This will prevent petroleum from contaminating the upstream reaches of the marsh and creeks. The site is rather large and boom deployment across the entire bay would not result in protection at this site. The deflection of oil to collection areas would move the oil into the slower current areas of the river and help during tidal changes. A minimum of thirty-six (36) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent boom tending. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Site 10 - No-Name Island

Identification

Site Name:	No-Name Island
Location:	South – downstream approximately 1.1 miles
Waterbody:	Cape Fear River
Priority:	High

Site Characteristics

Shoreline Types

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Vegetated Riverine Banks

- Either low banks with grasses or low eroding banks with trees and tree roots exposed to the water.
- The banks are flooded occasionally by high water.
- These shorelines are generally found in fresh or brackish water localities.

Fine Grained Sand Beaches

- These beaches are generally flat and hard-packed.
- Although these are predominantly fine sand, there is often a small amount of shell or shell hash.
- There can be heavy accumulation of wrack present.
- They are utilized by birds and turtles for nesting and feeding.
- Upper beach fauna includes ghost crabs and amphipods; lower beach fauna can be moderate, but highly variable.

Rare & Endangered Species

None Noted

Bird Concentrations

None Noted

Land Use

- Undeveloped

Seasonal Considerations

- None Noted

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Vegetated Riverine Banks

- During low water stages there could be little impact, with the oil coating a narrow band of sediment at the water level.
- During high water, the oil will cover and coat the grasses and base of the trees.
- May cause loss of the grasses, but the trees should survive unless oil penetrates and persists in the substrates.

Fine Grained Sand Beach

- Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone.
- Heavy oil accumulations will cover the entire beach surface; oil will be lifted off the lower beach with the rising tide.
- Maximum penetration of oil into fine-grained sand is about 10 cm.
- Burial of oil layers by clean sand within the first week after a spill typically will be less than 30 cm along the upper beach face.
- Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water.
- Biological impacts include temporary declines in fauna, which can affect important shorebird foraging areas.

Protection Plan

Approximately 2,500 feet of boom should be across the northernmost point of the island in an effort to deflect the oil away form the shoreline. This will prevent petroleum from contaminating the hard to clean areas associated with this island. The site is rather large and boom deployment around the entire island, although desirable, would not be feasible in the amount of time available until oil could reach the site.

The deflection of oil to collection areas would move the oil into the slower current areas of the river and help during tidal changes. A minimum of twenty-six (26) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent boom tending. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom. Depending upon the trajectory of the oil, the west side of the island may require additional boom along the marsh area. There are several sand beaches available for collection areas below the marsh if needed.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Vegetated Riverine Banks

- Low-pressure flushing of oiled areas is effective in removing moderate to heavy accumulations of oil from along the banks.
- Sorbent and containment boom should be placed on the waterside of cleanup operations to contain and collect oil outflow.
- Low-to-high-pressure flushing can be used to remove oil from the tree roots and trunks, if deemed necessary in high-use areas.

Fine Grained Sand Beach

- These beaches are among the easiest shoreline types to clean.
- Cleanup should concentrate on removing oil and oily debris from the upper swash zone once oil has come ashore.
- Traffic through both oiled and dune areas should be severely limited to prevent contamination of clean areas.
- Activity through both oiled and dune areas should be limited to prevent contamination of clean areas.
- Manual cleanup, rather than road graders and front end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal.
- All efforts should focus on preventing the mixture of oil deeper into the sediments by vehicular and foot traffic.
- Mechanical reworking of lightly oiled sediments from the high tide line to the upper intertidal zone can be effective along outer beaches.

Site 11 - Barnards Creek

Identification

Site Name:	Barnards Creek
Location:	South - downstream approximately 1.8 miles
Waterbody:	Cape Fear River
Priority:	High

Site Characteristics

Shoreline Type

Salt and Brackish Marsh

- These marshes contain vegetation that tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Rare & Endangered Species

- Shortnose Sturgeon
- American Alligator

Bird Concentrations

None Noted

Land Use

- Undeveloped

Seasonal Considerations

- Bay Anchovy spawning April through September.
- Mummichog spawning April through September.
- Sheephead minnow spawning April through October.
- Striped bass spawning March through May.
- American oyster spawning May through October.
- American Alligator nesting June through July with hatchlings August through September.

- Brackishwater Clam spawning and larvae March through May and August through September.
- Grass shrimp spawning February through October.

SPILL RESPONSE

Predicted Oil Behavior

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Protection Plan

Approximately 800 feet of boom should be deployed across the creek at this location. This will prevent petroleum from contaminating in inland reaches of the creek and the associated resources on an incoming tide. A minimum of nine (9) anchor sets will be required to properly secure the boom. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

Site 12 - Town Creek

Identification

Site Name:	Town Creek
Location:	South - downstream approximately 3.5 miles
Waterbody:	Cape Fear River
Priority:	High

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Rare & Endangered Species

- Shortnose Sturgeon
- American Alligator

Bird Concentrations

None Noted

Land Use

- Undeveloped

Seasonal Considerations

- Bay Anchovy spawning April through September.
- Mummichog spawning April through September.
- Sheephead minnow spawning April through October.
- Striped bass spawning March through May.
- American oyster spawning May through October.
- American Alligator nesting June through July with hatchlings August through September.
- Brackishwater Clam spawning and larvae March through May and August through September.
- Grass shrimp spawning February through October.

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Protection Plan

Approximately 800 feet of boom should be deployed across the creek mouth at this site. This will prevent petroleum from contaminating the upstream reaches of the creeks. The creek is rather large and currents may prohibit boom deployment across the entire creek. In the event that deployment across the creek is not possible, deflection booming should be employed in an effort to deflect the oil towards the shoreline or away from the site. The deflection of oil to collection areas would move the oil into the slower current areas of the river and help during tidal changes. A minimum of nine (9) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent boom tending. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Site 13 - Campbell Island

Identification

Site Name:	Campbell Island
Location:	South - downstream approximately 3.5 miles
Waterbody:	Cape Fear River
Priority:	High

Site Characteristics

Shoreline Type

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Rare & Endangered Species

- Shortnose Sturgeon

Bird Concentrations

None Noted

Land Use

- Undeveloped

Seasonal Considerations

- Bay Anchovy spawning April through September.
- Mummichog spawning April through September.
- Sheephead minnow spawning April through October.
- Striped bass spawning March through May.
- Grass shrimp spawning February through October.

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Protection Plan

Approximately 1,800 feet of boom should be deployed across the shoreline of the northernmost point of the island. Also, boom should be provided for protection of the exposed tidal flats located along the southeastern shore of the island. In addition the deflection of oil to collection areas would move the oil into the slower current areas of the river and help during tidal changes. A minimum of twenty (20) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent boom tending.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Site 14 - Keg Island

Identification

Site Name: Keg Island
Location: South – downstream approximately 4.75 miles
Waterbody: Cape Fear River
Priority: High

Site Characteristics

Shoreline Types

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Vegetated Riverine Banks

- Either low banks with grasses or low eroding banks with trees and tree roots exposed to the water.
- The banks are flooded occasionally by high water.
- These shorelines are generally found in fresh or brackish water localities.

Rare & Endangered Species

None Noted

Bird Concentrations

None Noted

Land Use

- Undeveloped

Seasonal Considerations

None Noted

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Vegetated Riverine Banks

- During low water stages there could be little impact, with the oil coating a narrow band of sediment at the water level.
- During high water, the oil will cover and coat the grasses and base of the trees.
- May cause loss of the grasses, but the trees should survive unless oil penetrates and persists in the substrates.

Protection Plan

Approximately 2,000 feet of boom should be across the northwestern shoreline of the island in an effort to deflect the oil away form the scarps and marshes. This will prevent petroleum from contaminating the hard to clean areas associated with this island. The island is rather large and boom deployment around the entire island, although desirable, would not be feasible in the amount of time available until oil could reach the site. Along the western shoreline a natural pocket is formed and is bordered by tidal marsh. The deflection of oil away from this area is necessary to avoid extensive marsh impact. A minimum of twenty-five (25) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent boom tending. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom.

Depending upon the trajectory of the oil, the southeast side of the island may require additional boom along the marsh area.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Vegetated Riverine Banks

- Low-pressure flushing of oiled areas is effective in removing moderate to heavy accumulations of oil from along the banks.
- Sorbent and containment boom should be placed on the waterside of cleanup operations to contain and collect oil outflow.
- Low-to-high-pressure flushing can be used to remove oil from the tree roots and trunks, if deemed necessary in high-use areas.

Site 15 - Snow's Cut

Identification

Site Name:	Snow's Cut
Location:	South – downstream approximately 9.4 miles
Waterbody:	Cape Fear River
Priority:	High

Site Characteristics

Shoreline Types

Sheltered Scarps in Mud

- Sheltered scarps form by boat-wake erosion of marsh fronts or muddy substrates along navigation channels.
- There may be some fringing marsh at the base of the scarp along the edge of the water.

Vegetated Riverine Banks

- Either low banks with grasses or low eroding banks with trees and tree roots exposed to the water.
- The banks are flooded occasionally by high water.
- These shorelines are generally found in fresh or brackish water localities.

Fine Grained Sand Beaches

- These beaches are generally flat and hard-packed.
- Although these are predominantly fine sand, there is often a small amount of shell or shell hash.
- There can be heavy accumulation of wrack present.
- They are utilized by birds and turtles for nesting and feeding.
- Upper beach fauna includes ghost crabs and amphipods; lower beach fauna can be moderate, but highly variable.

Rare & Endangered Species

Shortnose Sturgeon

Bird Concentrations

None Noted

Land Use

Undeveloped

Seasonal Considerations

None Noted

SPILL RESPONSE

Predicted Oil Behavior

Sheltered Scarps in Mud

- Oil will not adhere to the wet sediment surface but could penetrate burrows if present.
- Stranded oil will persist because of low energy setting.

Vegetated Riverine Banks

- During low water stages there could be little impact, with the oil coating a narrow band of sediment at the water level.
- During high water, the oil will cover and coat the grasses and base of the trees.
- May cause loss of the grasses, but the trees should survive unless oil penetrates and persists in the substrates.

Fine Grained Sand Beach

- Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone.
- Heavy oil accumulations will cover the entire beach surface; oil will be lifted off the lower beach with the rising tide.
- Maximum penetration of oil into fine-grained sand is about 10 cm.
- Burial of oil layers by clean sand within the first week after a spill typically will be less than 30 cm along the upper beach face.
- Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water.
- Biological impacts include temporary declines in fauna that can affect important shorebird foraging areas.

Protection Plan

Approximately 500 feet of boom should be deployed at the north shore of the canal in an effort to deflect the oil into the shoreline for collection prior to entering the canal. An additional 500-foot deployment should be placed across the canal entrance to deflect oil to the south the south of the canal. As a precaution, additional boom can be placed across the canal at various points as necessary. This will prevent petroleum from entering the canal and possibly migrating to the beaches. The deflection of oil to collection areas would move the oil into the slower current areas of the river and help during tidal changes. A minimum of sixteen (16) anchor sets will be required to properly secure the boom. This boom should be marked with lighted buoys and provided frequent boom tending. Shoreline anchors may be used if a tree of sufficient size is not available for securing the ends of the boom. Depending upon the currents it may not be possible to boom across the canal and deflection booming should be employed.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Sheltered Scarps in Mud

- Where the high-tide area is accessible, it may be feasible to remove heavy oil accumulations and debris.
- The muddy substrate cannot support heavy equipment, and even foot traffic could disrupt the sediments and mix oil deeper.

Vegetated Riverine Banks

- Low-pressure flushing of oiled areas is effective in removing moderate to heavy accumulations of oil from along the banks.
- Sorbent and containment boom should be placed on the waterside of cleanup operations to contain and collect oil outflow.
- Low-to-high-pressure flushing can be used to remove oil from the tree roots and trunks, if deemed necessary in high-use areas.

Fine Grained Sand Beach

- These beaches are among the easiest shoreline types to clean.
- Cleanup should concentrate on removing oil and oily debris from the upper swash zone once oil has come ashore.
- Traffic through both oiled and dune areas should be severely limited to prevent contamination of clean areas.
- Activity through both oiled and dune areas should be limited to prevent contamination of clean areas.
- Manual cleanup, rather than road graders and front end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal.
- All efforts should focus on preventing the mixture of oil deeper into the sediments by vehicular and foot traffic.
- Mechanical reworking of lightly oiled sediments from the high tide line to the upper intertidal zone can be effective along outer beaches.

Site 16 - Federal Point Tidal Flats

Identification

Site Name: Federal Point Tidal Flats
Location: South - downstream approximately 11.65 miles
Waterbody: Cape Fear River
Priority: High

Site Characteristics

Shoreline Type

Exposed Tidal Flats

- Exposed tidal flats are broad intertidal areas composed primarily of sand and minor amounts of sand and mud.
- The presence of sand indicates that tidal currents and waves are strong enough to mobilize the sediments.
- They are usually associated with another shoreline type on the landward side of the flat, though they can occur as separate shoals; they are commonly associated with tidal inlets.
- Biological utilization can be very high, with large numbers of infauna, heavy use by birds for roosting and foraging, and use by foraging fish.

Salt and Brackish Marsh

- These marshes contain vegetation that tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Rare & Endangered Species

- Shortnose Sturgeon

Bird Concentrations

None Noted

Land Use

- Undeveloped

Seasonal Considerations

None Noted

SPILL RESPONSE

Predicted Oil Behavior

Exposed Tidal Flats

- Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high-tide line.
- Deposition of oil on the flat may occur in a falling tide if concentrations are heavy.
- Oil does not penetrate water-saturated sediments.
- Biological damage may be severe, primarily to infauna, thereby reducing food sources for birds and other predators.

Salt and Brackish Marshes

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Protection Plan

Approximately 6,500 feet of boom should be deployed across the exposed flats at this location. This will prevent petroleum from contaminating in flats and the marsh fringes. A minimum of sixty (60) anchor sets will be required to properly secure the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Care must be taken to ensure the boom deployments are below the low-tide line to prevent boom stranding and contamination. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Exposed Tidal Flats

- Currents and waves can be very effective in natural removal of the oil.
- Cleanup is very difficult (and possible only during low tides).
- The use of heavy machinery should be restricted to prevent mixing of oil into the sediments.

Salt and Brackish Marsh

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

Site 17 - Snow's Point

Identification

Site Name: Snow's Point
Location: South - downstream approximately 14.75 miles
Waterbody: Cape Fear River
Priority: Medium

Site Characteristics

Shoreline Type

Salt and Brackish Marsh

- These marshes contain vegetation that tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Fine Grained Sand Beaches

- These beaches are generally flat and hard packed.
- Though these are predominately fine sand, there is often an amount of shell or shell hash.
- There can be heavy accumulations of wrack present.
- They are utilized by birds and turtles for nesting and feeding.
- Upper beach fauna includes ghost crabs and amphipods; lower beach fauna can be moderate, but highly variable.

Rare & Endangered Species

- Shortnosed Sturgeon

Bird Concentrations

- High - Bonaparte's gull, Forster's tern, Great egret, Hooded Merganser, Laughing gull, Ring-billed gull, Snowy egret

Land Use

- Undeveloped

Seasonal Considerations

- American Oyster spawning May through November and larvae May through November.
- Brackishwater clam spawning August through October and March through May.
- Grass shrimp spawning February through October.
- Quahog spawning April through November and larvae through December.

SPILL RESPONSE

Predicted Oil Behavior

Salt and Brackish Marsh

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Fine Grained Sand Beach

- Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone.
- Heavy oil accumulations will cover the entire beach surface; oil will be lifted off the lower beach with the rising tide.
- Maximum penetration of oil into fine-grained sand is about 10 cm.
- Burial of oil layers by clean sand within the first week after a spill typically will be less than 30 cm along the upper beach face.
- Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water.
- Biological impacts include temporary declines in infauna, which can affect important shorebird foraging area.

Protection Plan

Approximately 3,500 feet of boom should be deployed across the inlets and creeks at this location. This will prevent petroleum from contaminating the extensive marshes associated with the area. A minimum of forty (40) anchor sets will be required to properly secure the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Care must be exercised in the deployment of the boom to ensure that the boom does not become stranded at low tides. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Salt and Brackish Marsh

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

Fine Grained Sand Beach

- These beaches are among the easiest shoreline types to clean.
- Cleanup should concentrate on removing oil and oily debris from the upper swash zone once oil has come ashore.
- Traffic through both oiled and dune areas should be severely limited to prevent contamination of clean areas.
- Activity through both oiled and dune areas should be limited to prevent contamination of clean areas.
- Manual cleanup, rather than road graders and front end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal.
- All efforts should focus on preventing the mixture of oil deeper into the sediments by vehicular and foot traffic.
- Mechanical reworking of lightly oiled sediments from the high tide line to the upper intertidal zone can be effective along outer beaches.

Site 18 - Federal Point Ferry

Identification

Site Name:	Federal Point Ferry
Location:	South - downstream approximately 14.75 miles
Waterbody:	Cape Fear River
Priority:	Medium

Site Characteristics

Shoreline Type

Salt and Brackish Marsh

- These marshes contain vegetation that tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Sheltered Manmade Structure

- These structures are solid manmade structures such as seawalls, groins, revetments, piers, and port facilities.
- Most structures are constructed of concrete wood or metal.
- Often there is no exposed beach at low tide, but multiple habitats may be present.
- Most of the structures are designed to protect a single lot, thus their composition, design and condition are highly variable.
- Attached animal and plant life can be moderate to high.

Rare & Endangered Species

- Shortnosed Sturgeon

Bird Concentrations

- High - Bufflehead, Common Loon, Double Crested Cormorant, Goldeneye, Horned Grebe, Merganser, Red Throated Loon, Ring Necked Duck, Ruddy Duck, Scaup

Land Use

- Commercial and undeveloped areas

Seasonal Considerations

None Noted

SPILL RESPONSE

Predicted Oil Behavior

Salt and Brackish Marsh

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Sheltered Manmade Structures

- Oil will adhere readily to the rough surface, particularly along the high-tide line, forming a distinct oil band.
- The lower intertidal zone usually stays wet (particularly if algae covered), preventing oil from adhering to the surface.

Protection Plan

Approximately 2,500 feet of boom should be deployed across the harbor and along the point to the north. This will prevent petroleum from contaminating the marshes associated with the point and the harbor area. A minimum of twenty-six (26) anchor sets will be required to properly secure the boom. Boom tending must be provided continuously and coordinated with the ferry. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial

containment. Care must be exercised in the deployment of the boom to ensure that the boom does not become stranded at low tides. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Salt and Brackish Marsh

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

Sheltered Manmade Structures

- Cleanup of seawalls is usually conducted for aesthetic reasons or to prevent the leaching of oil.
- Low-to-high pressure spraying at ambient water temperatures is most effective when the oil is fresh.

Site 19 - The Basin

Identification

Site Name: The Basin
Location: South - downstream approximately 15.0 miles
Waterbody: Cape Fear River
Priority: Medium

Site Characteristics

Shoreline Type

Exposed Manmade Structure

- These structures are solid manmade structures such as seawalls, groins, revetments, piers, and port facilities.
- They are constructed of concrete, wood or metal.
- Often there is no exposed substrate at low tide, but multiple habitats may be present.
- They are built to protect the shore from erosion by waves, boat wakes, and currents, and thus are exposed to rapid natural removal processes.
- Attached animals and plants are sparse to moderate.

Rare & Endangered Species

- Shortnosed Sturgeon

Bird Concentrations

- High - American Oystercatcher, Black-Bellied Plover, Dunlin, Greater Yellowlegs, Least Sandpiper, Marbled Godwit, Red Knot, Ruddy Turnstone, Saunderling, Semipalmated plover, Semipalmated sandpiper, Short-Billed Dowitcher, Western Sandpiper, Whimbrel, White Ibis, Willet, Bufflehead, Common Loon, Double-crested cormorant, Goldeneye, Horned Grebe, Merganser, Red-Throated loon, Ring-necked duck, Ruddy duck, Scaup.
- Medium - Black-crowned night heron, Cattle egret, Glossy ibis, Great Blue heron, Great egret, Green-backed heron, Little Blue Heron, Snowy egret, Tricolored heron

Land Use

- Marine Sanctuary, Undeveloped

Seasonal Considerations

None Noted

Predicted Oil Behavior

Exposed Manmade Structures

- Oil is held offshore by waves reflecting off the steep, hard surface in exposed settings.
- Oil readily adheres to the dry rough surfaces, but it does not adhere to wet substrates.
- The most resistant oil would remain as a patchy band at or above the high tide line.

Protection Plan

Approximately 3,500 feet of boom should be deployed across the structure to prevent petroleum contamination. A minimum of forty (40) anchor sets will be required to properly secure the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Care must be exercised in the deployment of the boom to ensure that the boom does not become stranded at low tides. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Although this site would normally not require protection, it is in the direct path of an oil slick traveling downstream on an outgoing tide. Protection of this site would prevent heavy concentrations of oil from impacting the site and the subsequent cleaning to prevent leaching. Bird populations also increase the site sensitivity.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Exposed Manmade Structure

- Cleanup is usually not required.
- High-pressure water spraying may be conducted to remove persistent oil in crevices, improve aesthetics; or prevent leaching of oil.

Site 20 - New Inlet

Identification

Site Name: New Inlet
Location: South - downstream approximately 18.8 miles
Waterbody: Cape Fear River and Atlantic Ocean
Priority: High

Site Characteristics

Shoreline Type

Exposed Tidal Flats

- Exposed tidal flats are broad intertidal areas composed primarily of sand and minor amounts of sand and mud.
- The presence of sand indicates that tidal currents and waves are strong enough to mobilize the sediments.
- They are usually associated with another shoreline type on the landward side of the flat, though they can occur as separate shoals; they are commonly associated with tidal inlets.
- Biological utilization can be very high, with large numbers of infauna, heavy use by birds for roosting and foraging, and use by foraging fish.

Salt and Brackish Marsh

- These marshes contain vegetation that tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Rare & Endangered Species

Piping Plover, Seabeach amaranth

Bird Concentrations

- High - American Oystercatcher, Black-bellied plover, Dunlin, Greater yellowlegs, Least sandpiper, Least tern, Marbled Godwit, Red Knot, Ruddy Turnstone, Saunderling, Semipalmated plover, Semipalmated sandpiper, Short-billed Dowitcher, Western Sandpiper, Whimbrel, Willet
- Medium - Black Skimmer, Caspian Tern, Common Tern, Royal Tern
- Low - Piping Plover

Land Use

Undeveloped

Seasonal Considerations

None Noted

SPILL RESPONSE

Predicted Oil Behavior

Exposed Tidal Flats

- Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high-tide line.
- Deposition of oil on the flat may occur in a falling tide if concentrations are heavy.
- Oil does not penetrate water-saturated sediments.
- Biological damage may be severe, primarily to infauna, thereby reducing food sources for birds and other predators.

Salt and Brackish Marshes

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Protection Plan

Approximately 8,500 feet of boom should be deployed across the exposed flats at this location. This will prevent petroleum from contaminating in flats and the marsh fringes. A minimum of ninety (90) anchor sets will be required to properly secure the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Care must be taken to ensure the boom deployments are below the low-tide line to prevent boom stranding and contamination. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Exposed Tidal Flats

- Currents and waves can be very effective in natural removal of the oil.
- Cleanup is very difficult (and possible only during low tides).
- The use of heavy machinery should be restricted to prevent mixing of oil into the sediments.

Salt and Brackish Marsh

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

Site 21 - Striking Island

Identification

Site Name: Striking Island
Location: South - downstream approximately 19.75 miles
Waterbody: Cape Fear River
Priority: High

Site Characteristics

Shoreline Type

Salt and Brackish Marsh

- These marshes contain vegetation that tolerates water salinities down to about 5 parts per thousand.
- The width of the marsh can vary widely, from a narrow fringe to extensive areas.
- Sediments are composed of organic-rich muds except on the margins of barrier islands where sand is abundant.
- Exposed areas are located along bays with wide fetches and along heavily trafficked waterways.
- Sheltered areas are not exposed to significant wave or boat wake activity.
- Resident flora and fauna are abundant with numerous species, high utilization by birds, fish and shellfish.

Rare & Endangered Species

None Noted

Bird Concentrations

- High - White Ibis
- Medium - Tricolored heron, Snowy egret, Little Blue Heron, Laughing gull, Green-backed heron, Great Egret, Great Blue Heron, Glossy Ibis, Cattle Egret, Black-Crowned Night Heron

Land Use

Undeveloped

Seasonal Considerations

Bird Rookery

Bird	Nesting	Laying	Hatching	Fledging
Black-Crowned Night Heron	March - Aug	March - June	April - July	June – Aug
Cattle Egret	April - Sept	April - July	May - July	June - Sept
Glossy Ibis	April - Aug	April - June	May - July	June – Aug
Great Egret	March - Aug	March - May	April - June	May - Aug
Green-Backed Heron	April - Aug	April - July	May - July	June – Aug
Laughing Gull	April - Aug	April - June	May - July	May - Aug
Little Blue Heron	April - Aug	April - June	April - July	May - Aug
Snowy Egret	April - Aug	April - June	April - July	July – Aug
Tricolored Heron	April - Aug	April – May	May – June	July – Aug
White Ibis	April - Aug	April - May	May - June	July - Aug

SPILL RESPONSE

Predicted Oil Behavior

Salt and Brackish Marsh

- Oil adheres readily to intertidal vegetation.
- The band of coating will vary widely, depending on the water level at the time oil slicks are in the vegetation. There may be multiple bands.
- Large slicks will persist through multiple tidal cycles and coat the entire stem of vegetation from the high tide line to the base.
- If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, although lighter oils can penetrate deeper to the limit of tidal influence.
- Medium to heavy oils do not readily adhere to or penetrate the fine sediments, but can pool on the surface or in burrows.
- Light oils can penetrate the top few centimeters of sediment and deeply into burrows and mud cracks (up to one (1) meter).

Protection Plan

Approximately 3,000 feet of boom should be deployed across the northern shorelines of the island. This will prevent petroleum from contaminating the extensive marshes associated with the area. A minimum of thirty (30) anchor sets will be required to properly secure the boom. Boom tending should be performed at tide changes to ensure the security of the anchors. Sorbent boom may be used behind the containment boom to collect oil that escapes the initial containment. Care must be exercised in the deployment of the boom to ensure that the boom does not become stranded at low tides. Wakes generated by vessel traffic may dislodge anchors and/or cause oil to breech the containment boom.

Exact booming requirements and locations will be determined by the Incident Commander in response to conditions at the time of the spill.

Response Considerations

Salt and Brackish Marsh

- Under light oiling, the best practice is to let the area recover naturally.
- Natural removal processes and rates should be evaluated prior to conducting cleanup.
- Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
- Cleanup activities should be carefully supervised to avoid vegetation damage.
- Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
- Cutting of oiled vegetation should only be considered when other resources present are at a great risk from leaving the oiled vegetation in place.

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